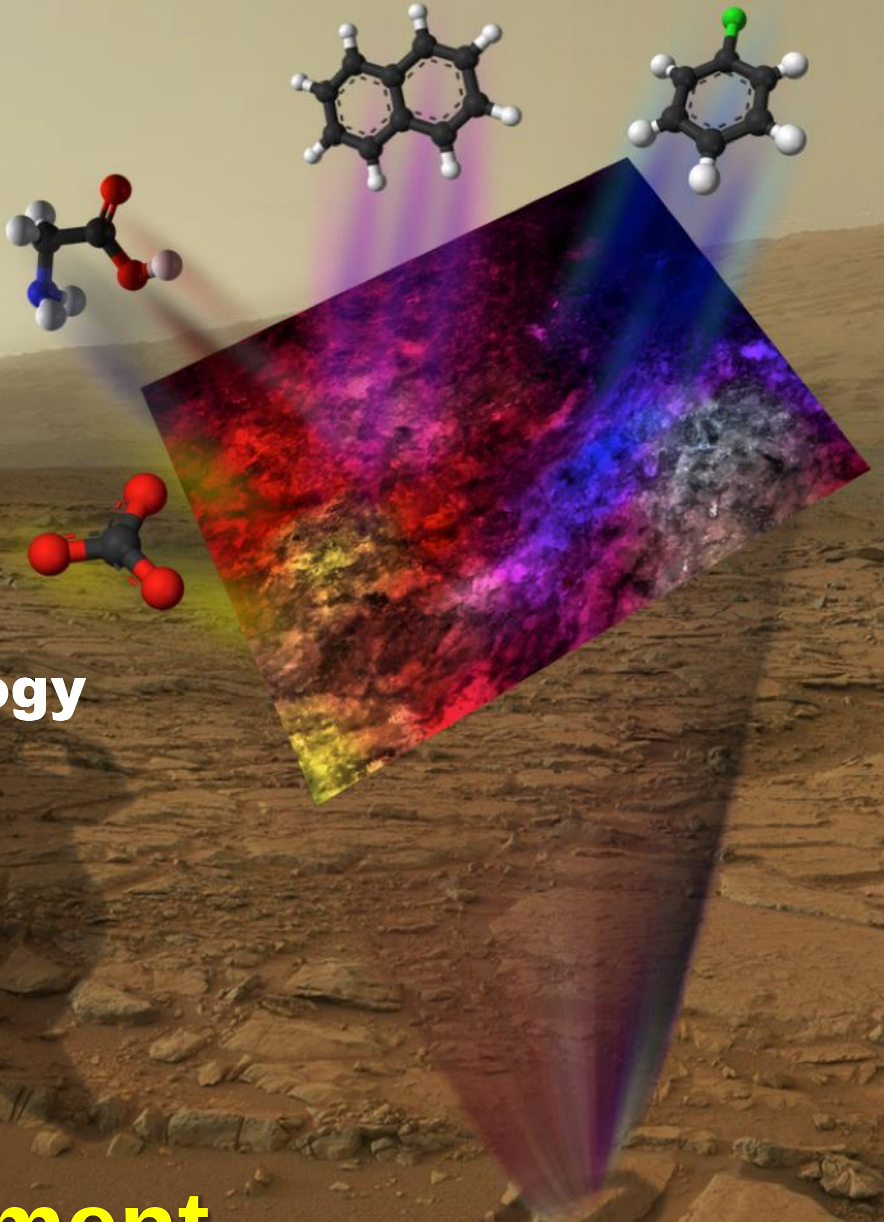
SHERLOC: Scanning Habitable Environments *with* Raman and Luminescence *for* Organics and Chemicals

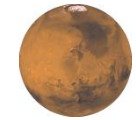
Luther Beegle, PI
Rohit Bhartia, Deputy PI
Jet Propulsion Laboratory,
California Institute of Technology



SHERLOC: an instrument overview.

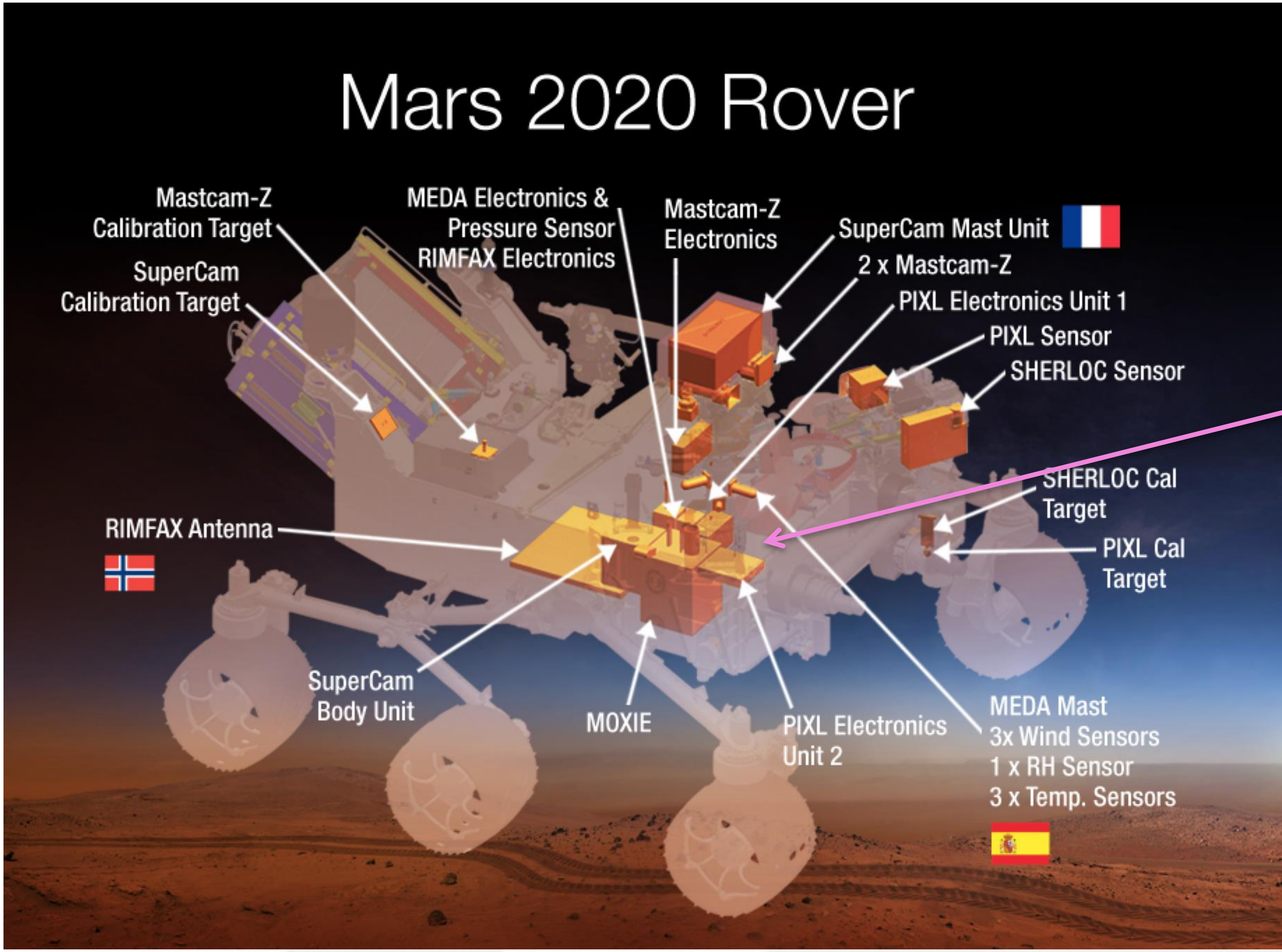
4/23/2020

Mars 2020: First leg of potential Sample Return from Mars



- 1998: Development of the SHERLOC Concept starts
  - Funded under internal JPL R&D, NASA HQ proposals and Small Business Proposals
- Announcement of 2020 mission in December of 2012
- SDT forms January 2013
- SHERLOC design beings in January 2013
- SDT report released May 2013
  - Geology
  - Potential biosignature identification (ORGANIC identification called out)
  - Caching of well-documented samples for potential return later in the decade
  - First human-to-mars type measurements.
- Proposals Due at HQ: January 2014
- Selections July 31, 2014
- Launch in August 2020
- Landing in February 2021
- End Primary mission January 2023
- Samples potentially picked up and returned to earth 20??

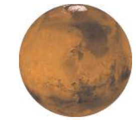
The Rover



SHERLOC Electronics Assembly

(not identified in NASA press release)

The Mars 2020 Payload



The "Spectroscopy Rover"

Mastcam – Z: High resolution zoom camera
PI: Jim Bell (ASU)

SuperCam: Elemental (LIBS), Mineralogy (IR, Visible Raman), Color imager
PI: Roger Weins (LANL)

PIXL: Elemental Maps (XRF)
PI: Abigail Allwood (JPL)

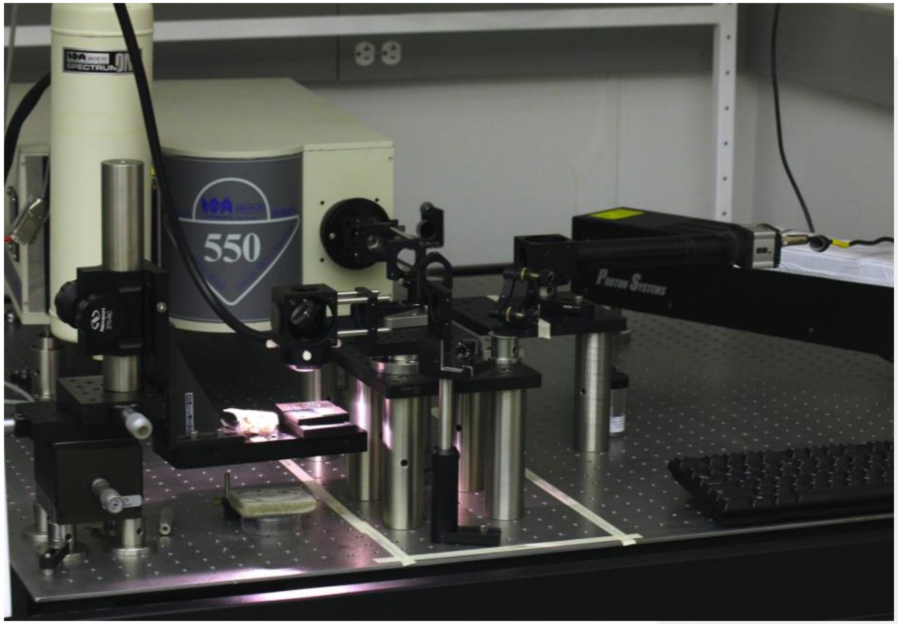
SHERLOC: *Organics and Astrobio. relevant min.* (Imager+DUV Fluor/Raman)
Microscopic to Infinity Imaging
PI: Luther Beegle (JPL)
Deputy PI: Rohit Bhartia (JPL)

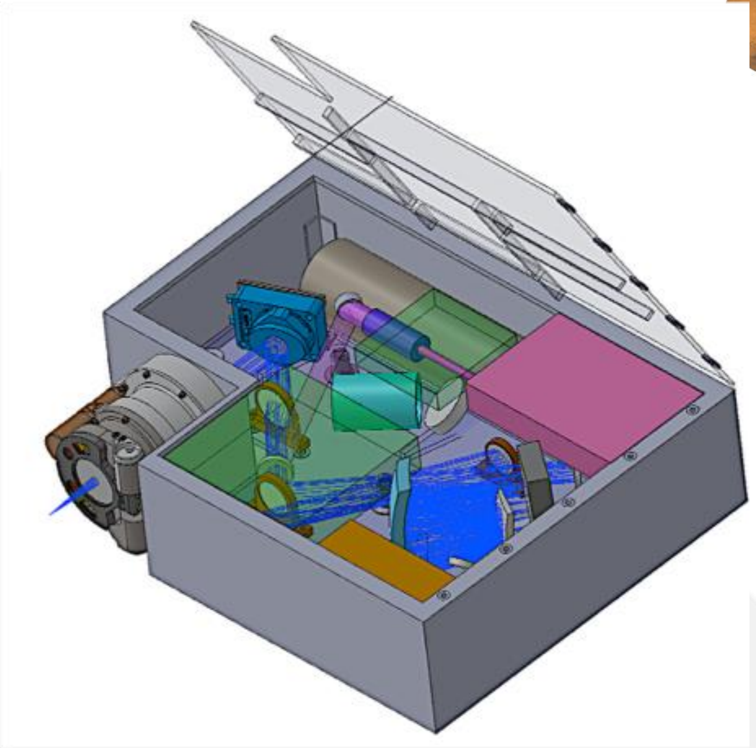
MEDA: Meteorological weather station
PI: J. Mandfredi (Spain)

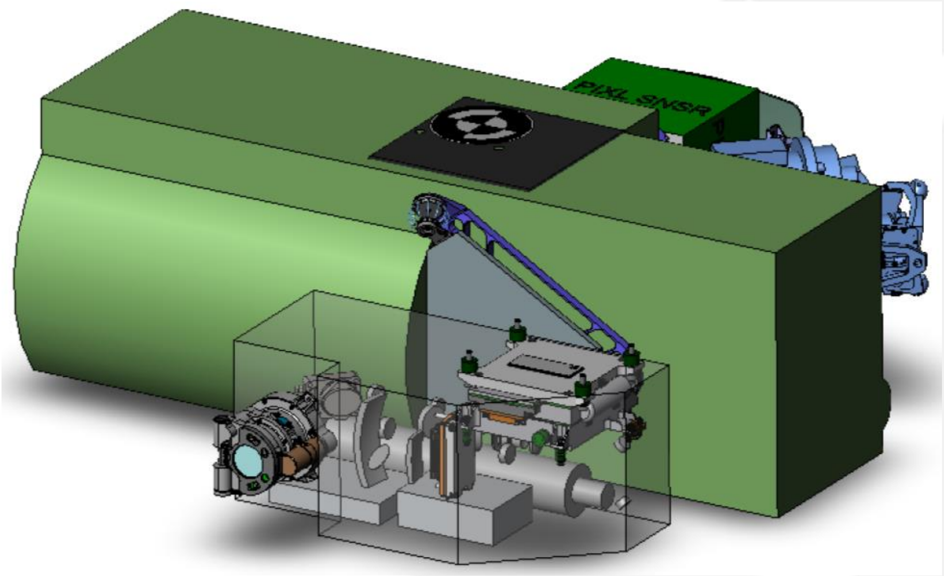
RIMFAX: Subsurface structure (GPR)
PI: Svein-Erik Hamran (Norway)

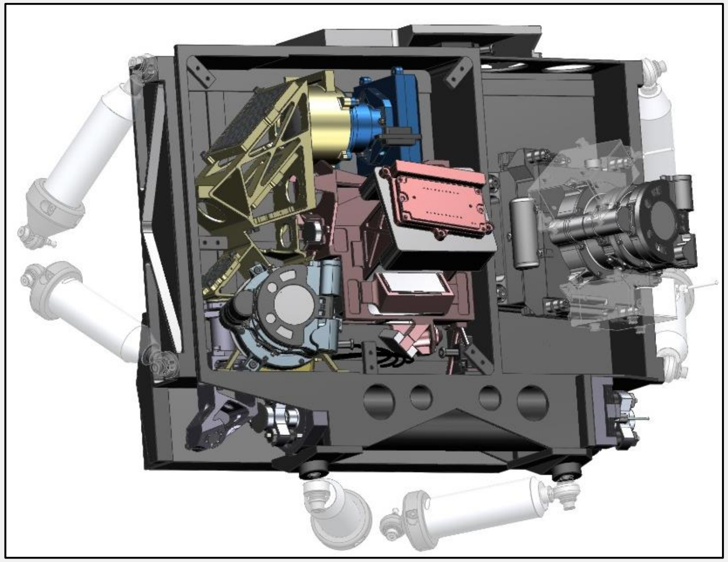
MOXIE: O2 generation on Mars
PI: Michael Hecht (MIT)

SHERLOC

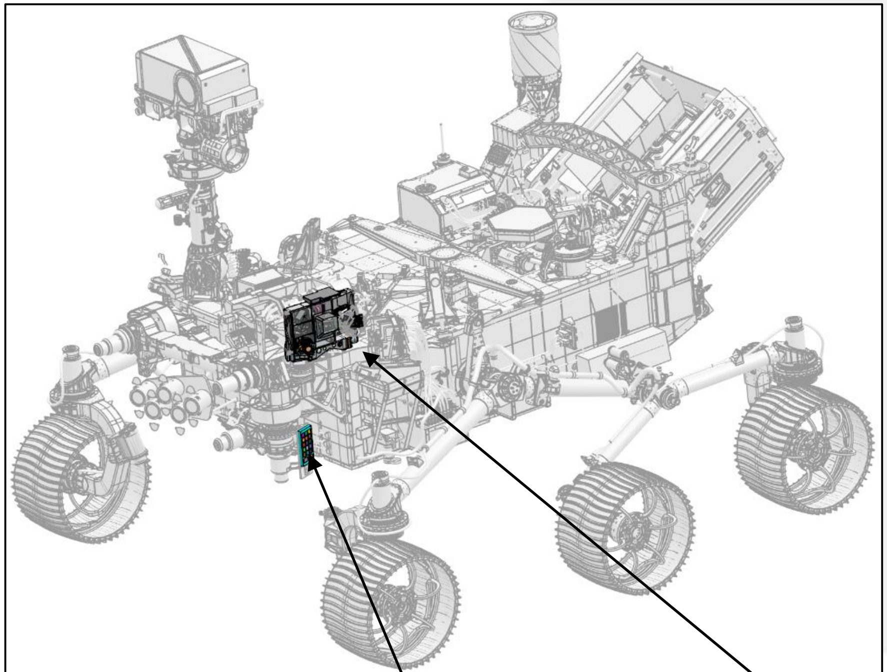


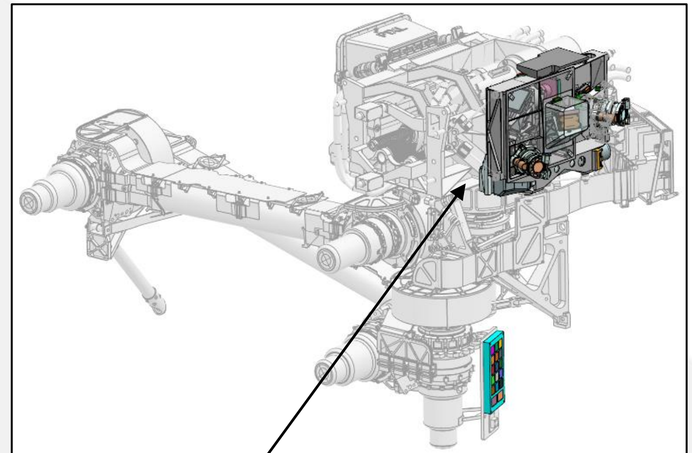


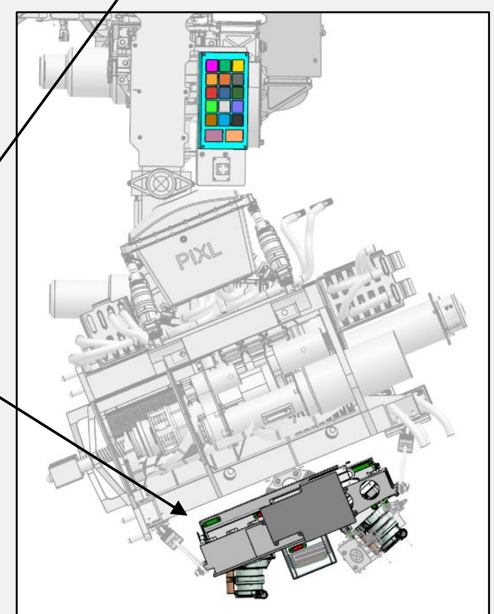




SHERLOC On the M2020 Rover





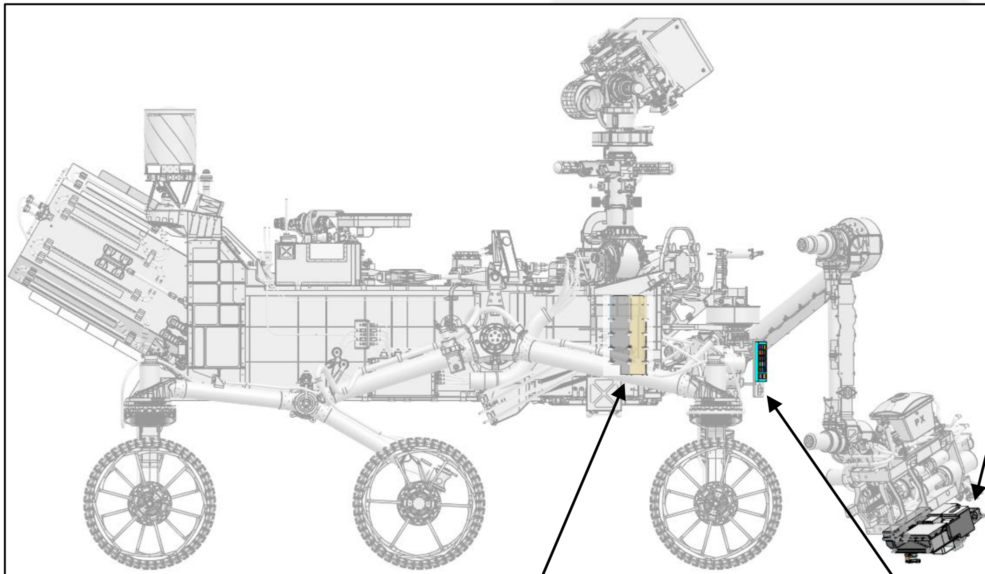


SHERLOC Body Assembly
(Inside Rover Chassis)

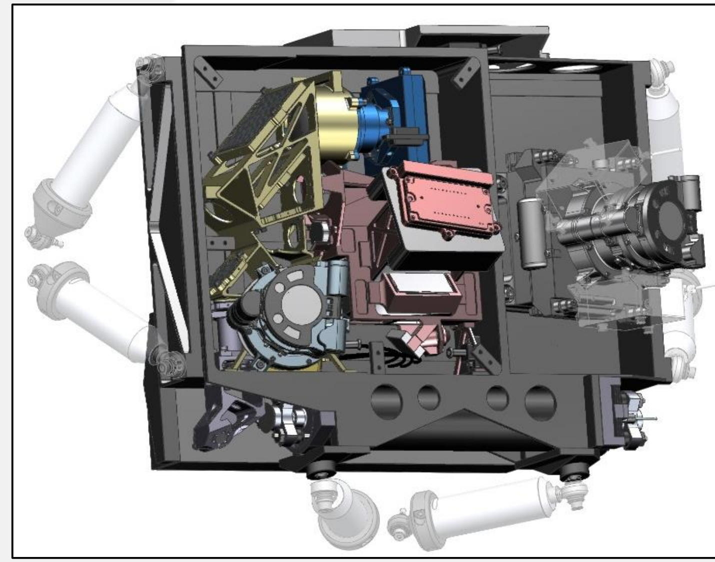
SHERLOC Calibration Target

SHERLOC Turret Assembly

SHERLOC On the M2020 Rover



SHERLOC Turret
Assembly



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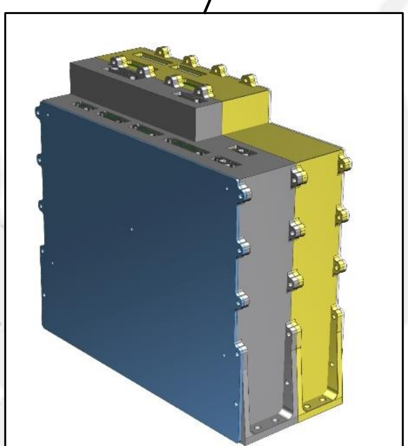

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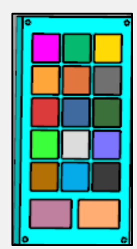


SHERLOC Investigation Team

Astrobiology


L. Beegle
(PI)


R. Bhartia
(D-PI)


K. Williford
(JPL)


K. Nealson
(USC)


P. Conrad
(GSFC)


A. Steele
(CIW)

Laser Raman Spectroscopy

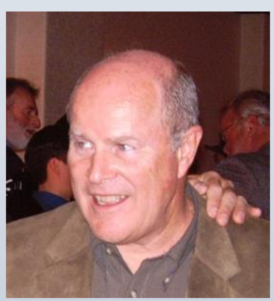

S. Asher
(Pitt Univ.)


P. Sorbon
(SETI)


M. Fries
(JSC)

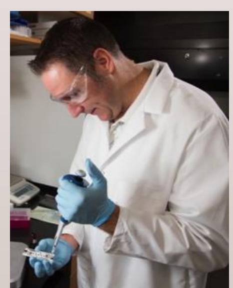

J. Popp
(Jena)


S. Clegg
(LANL)


W. Hug
(Photonsystems)

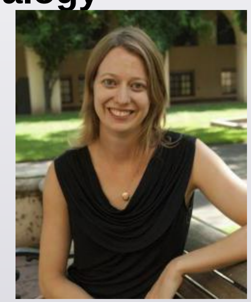
Meteoritics


R. Wiens
(LANL)


A. Burton
(JSC)

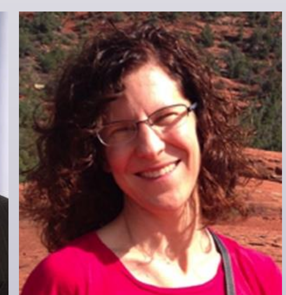
Geology/Mineralogy


K. Edgett
(MSSS)


B. Ehlmann
(Caltech)


L. Kah
(Univ. Tenn)


F. Langerhorst
(Jena)

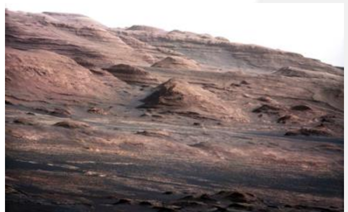

M. Minitti
(PSI)


A. Yingst
(PSI)

SHERLOC Investigation Team

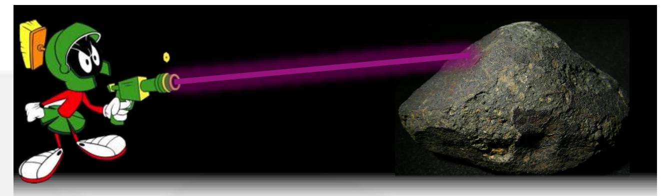
Astrobiology

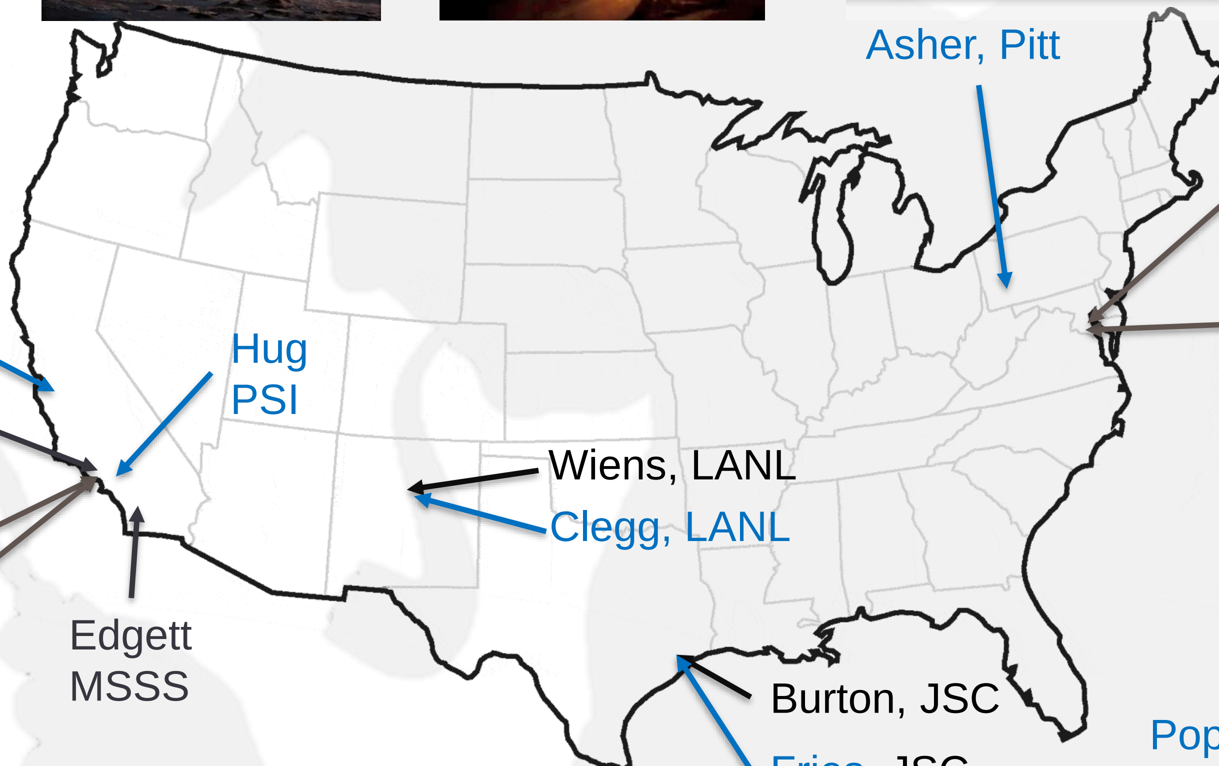
Geology



Meteoritics

Laser Raman Spectroscopy





SHERLOC Science goals

- *Assess the habitability potential of a sample and its aqueous history.*
- *Assess the availability of key elements and energy source for life (C,H,N,O,P,S etc)*
- *Determine if there are potential biosignatures preserved in Martian rocks and outcrops.*
- *Provide organic and mineral analysis for selective sample caching.*

To do this SHELROC does the following:

- *Detects* and *classifies* organics and astrobiologically relevant minerals on the surface and near subsurface of Mars.
- Organic sensitivity of 10^{-5} to 10^{-6} w/w over the observed area
- Organic sensitivity of 10^{-2} to 10^{-4} w/w spatially resolved at <100µm
- Astrobiologically Relevant mineral detection and classification to <100µm

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NASA's "working" Definition of Life

- A self sustaining system capable of Darwinian evolution.

Active spectroscopy

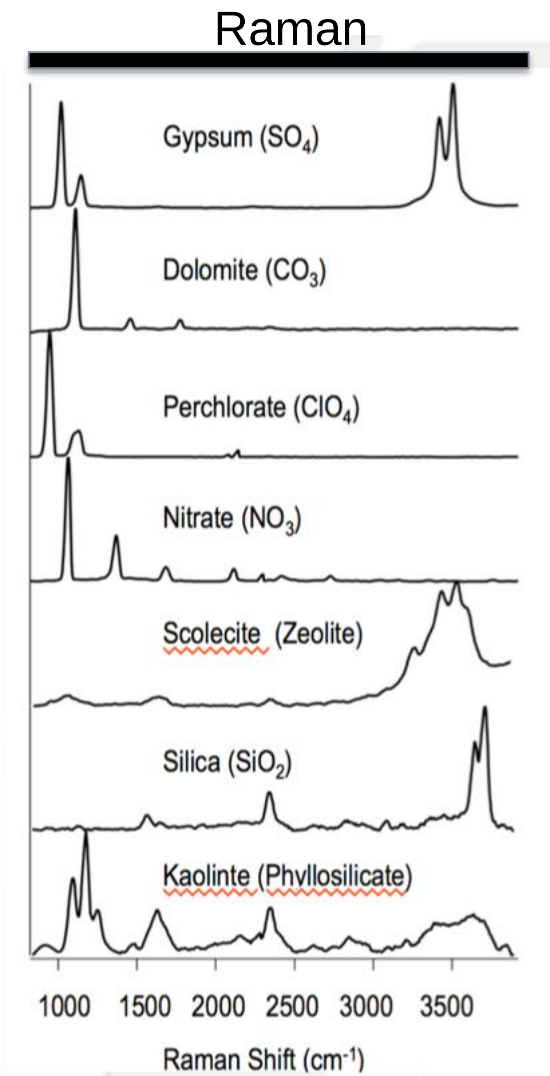
Bringing your own source

Advantages:

- Choose a wavelength of range of wavelengths to interact with a surface
- Observe interaction with the surface that are otherwise difficult to see
    - Fluorescence ← Organic rings
    - Raman ← Molecular structure
    - LIBS ← Elements
- Provides unique information about the sample

SHERLOC Capabilities

Astrobiology relevant minerals



Organics

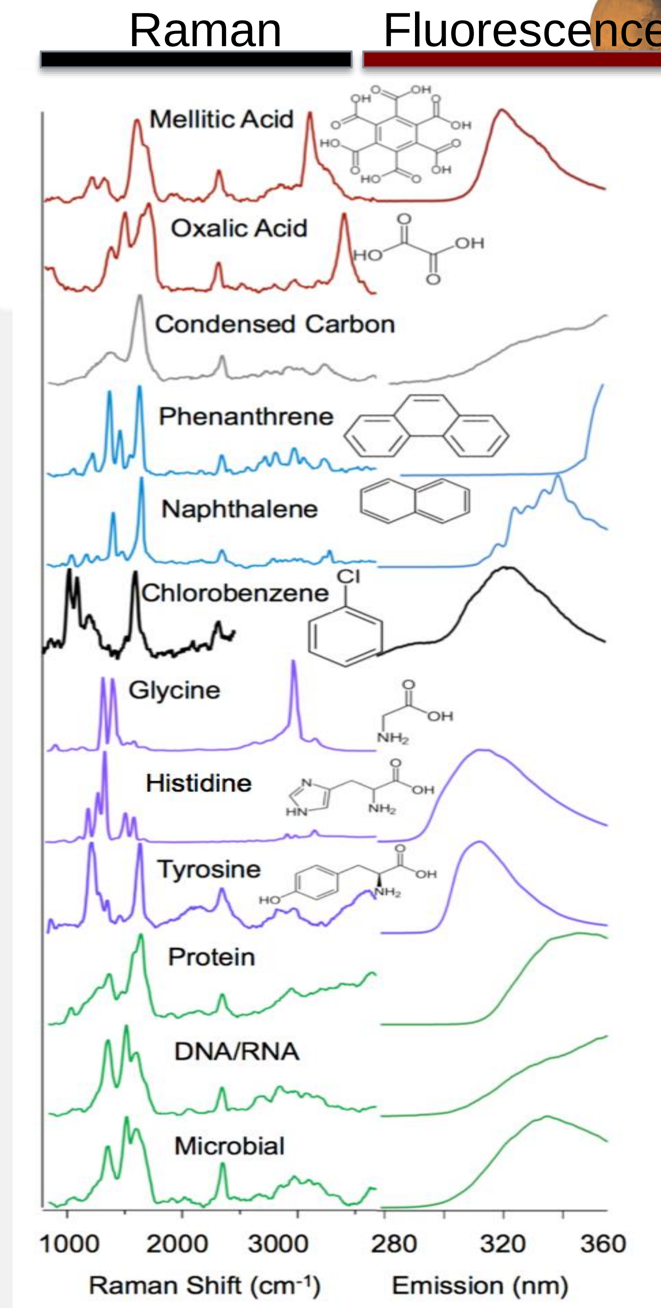
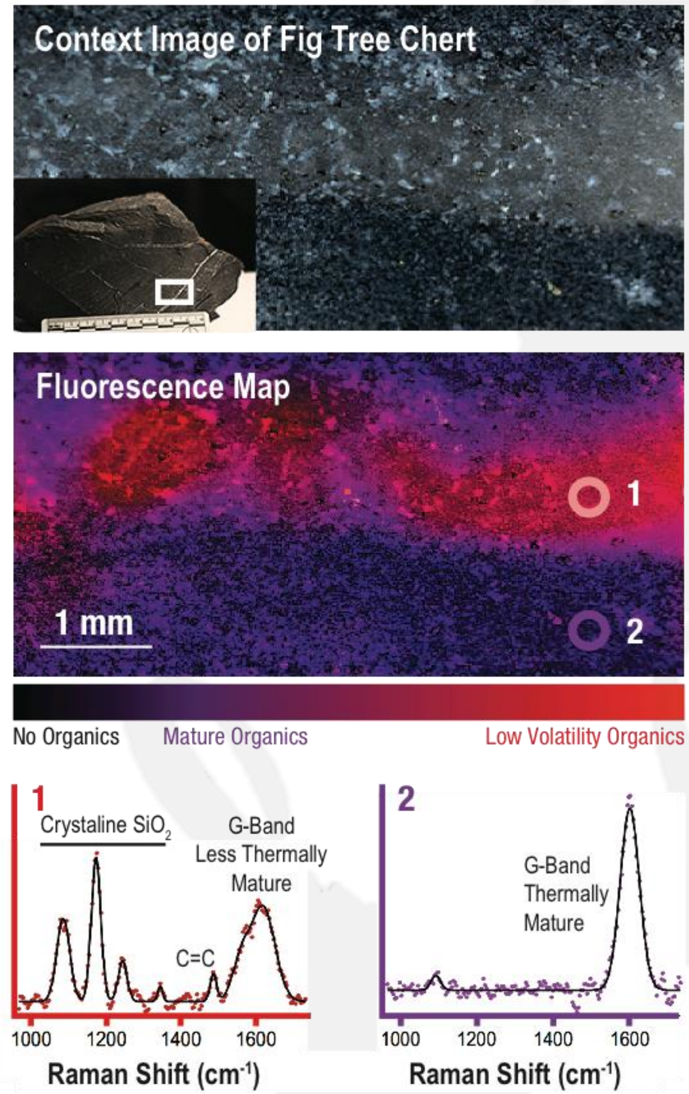


Fig Tree Chert Sample



SHERLOC DEMONSTRATION: FIG TREE CHERT. *A 3.2-3.5 Ga silica-rich, low-carbon rock that has yielded microfossils and stromatolites (c.f. Lowe and Byerly 1999).*

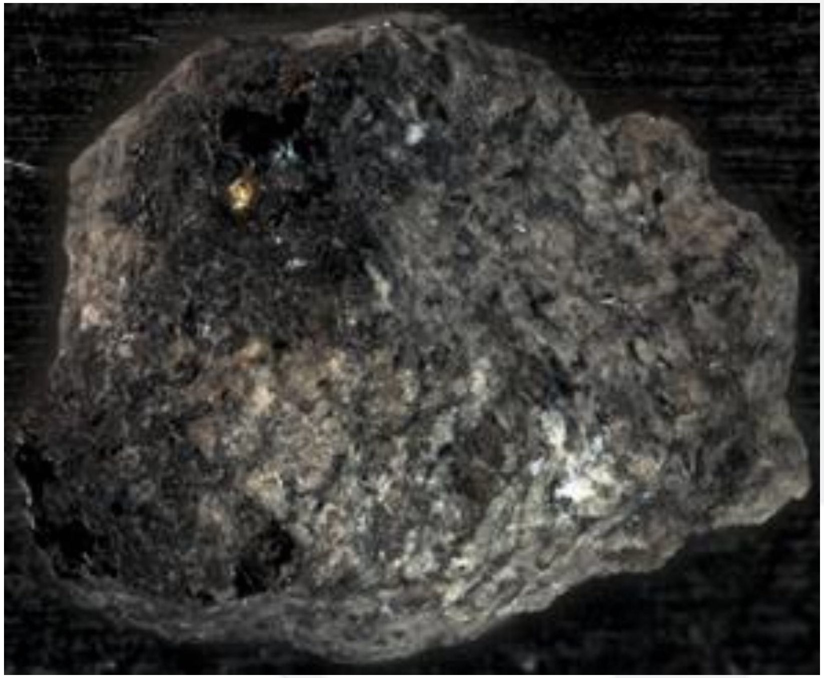
Using the SHLEORC prototype, a low-carbon standard from the Fig Tree formation was analyzed and shows both organics and mineral features that describe its environmental and aqueous history:

1. *Crystalline $Si0_2$ and DUV Raman C=C and G-band positions/widths show veins are aqueous, low temperature intrusion of silica and less mature organics.*

2. *DUV Raman G-band position/width shows the chert was exposed to temperatures >$600^{o}C$.*

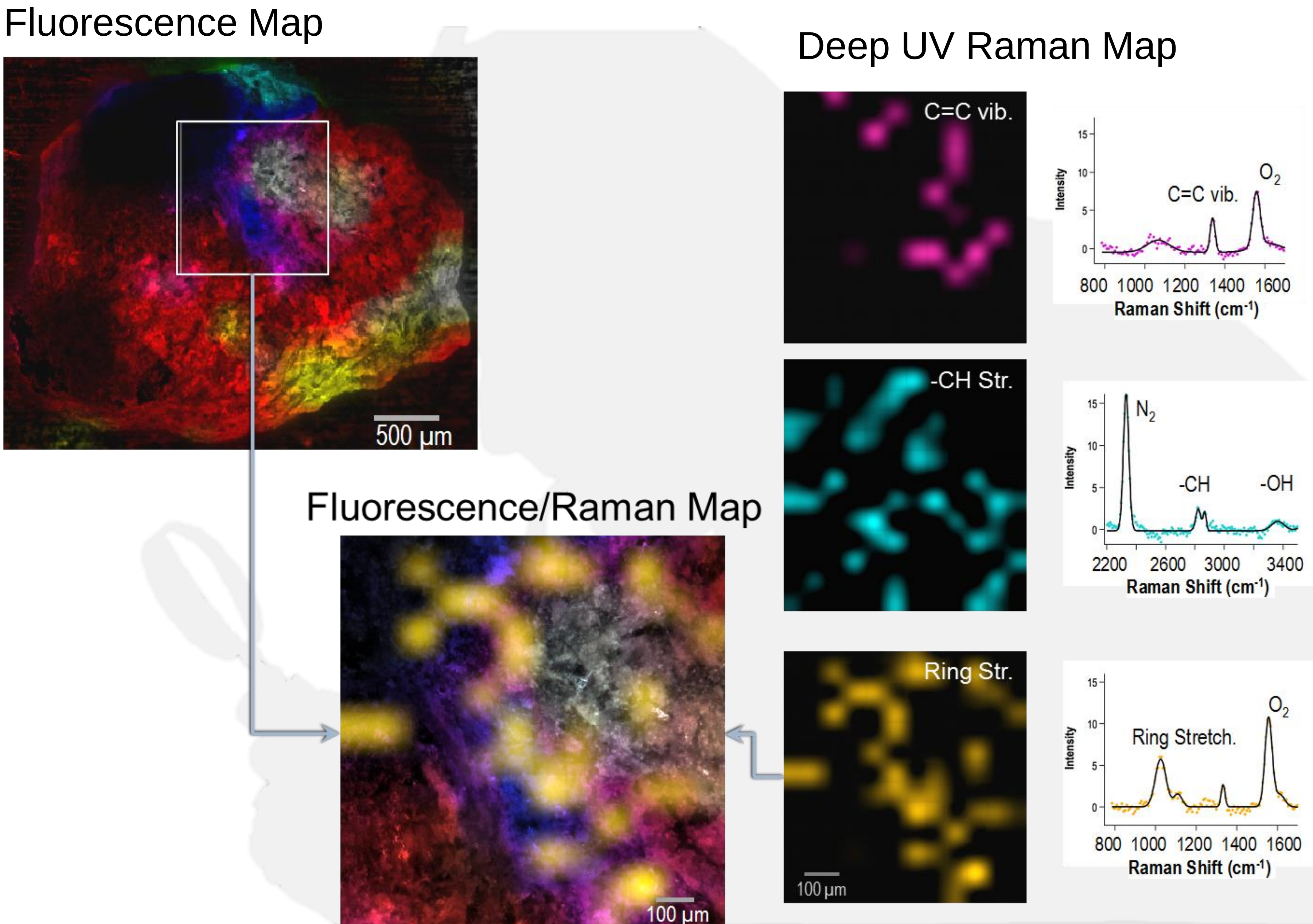
Tissint Meteorite: Imaging

Context Image (30µm resolution)



Surface Topographic Analysis

Tissint Meteorite DUV Raman Analysis

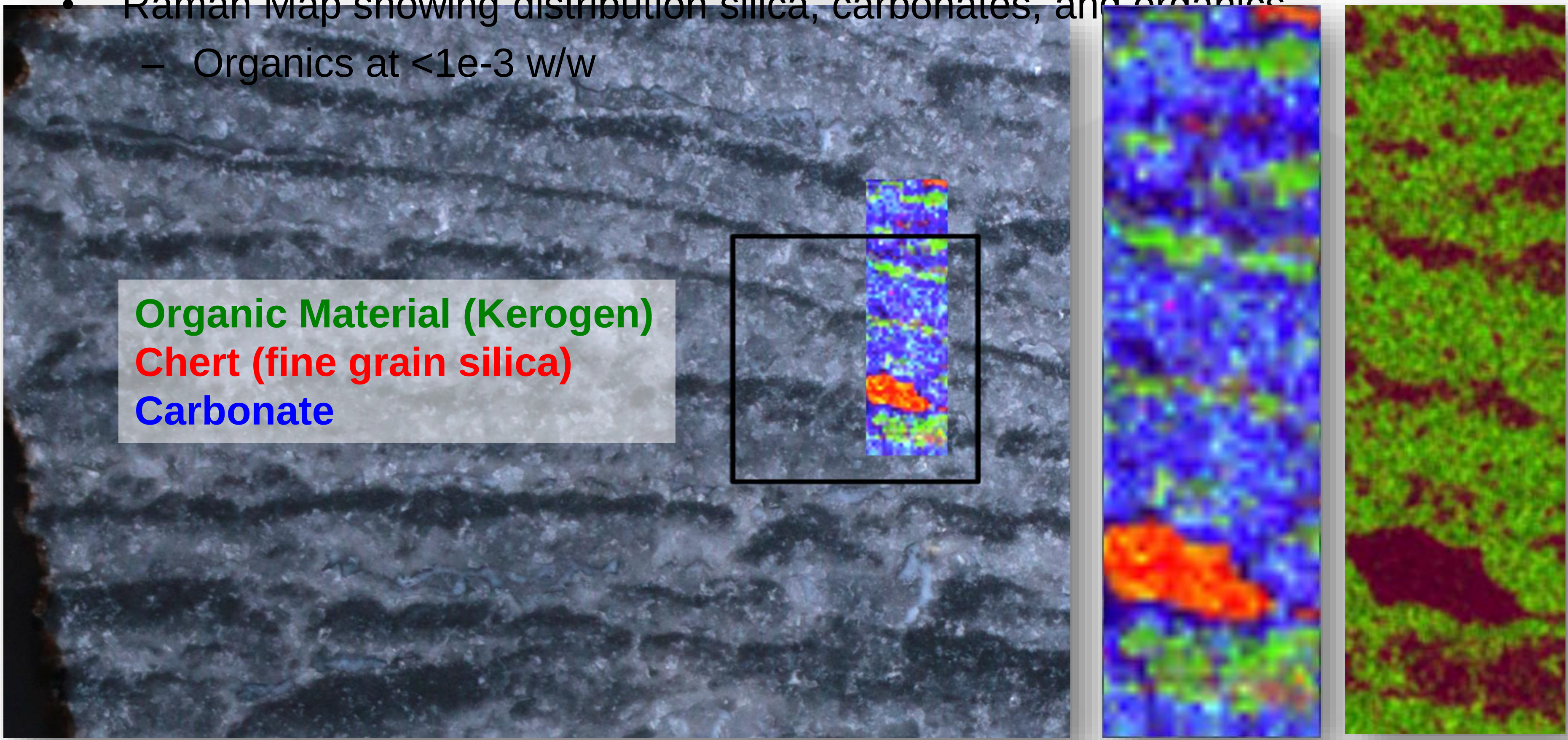


SHERLOC Science

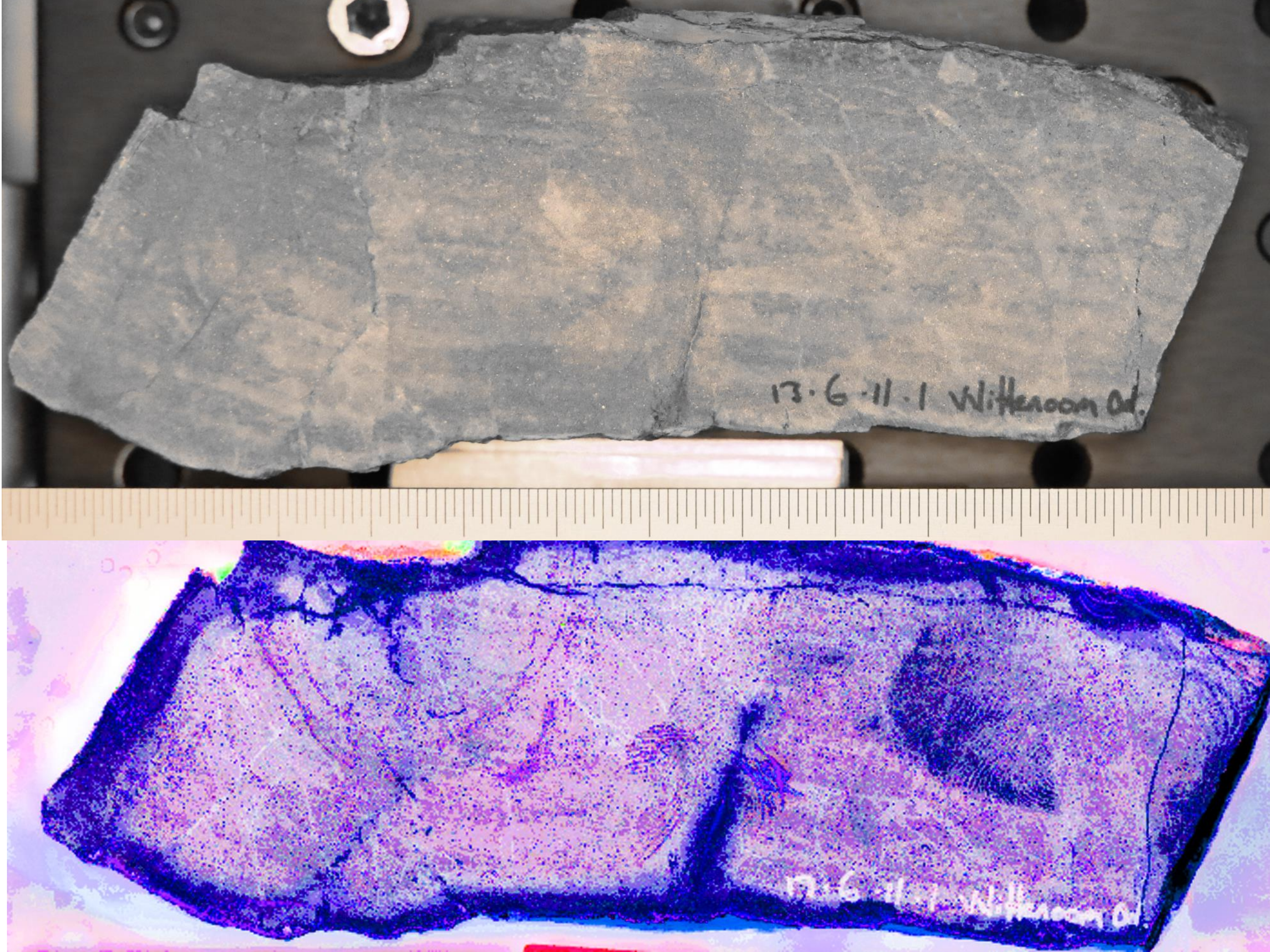
Detection and Classification of Organics and Minerals

- Raman Map showing distribution silica, carbonates, and organics
  - Organics at <1e-3 w/w

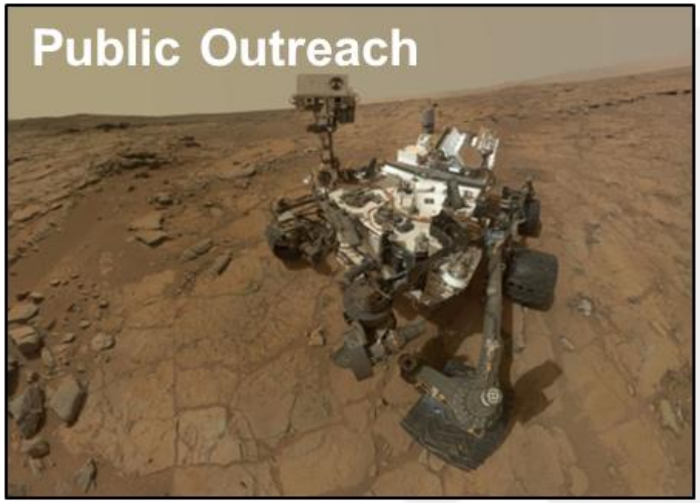
PIXL-like Data



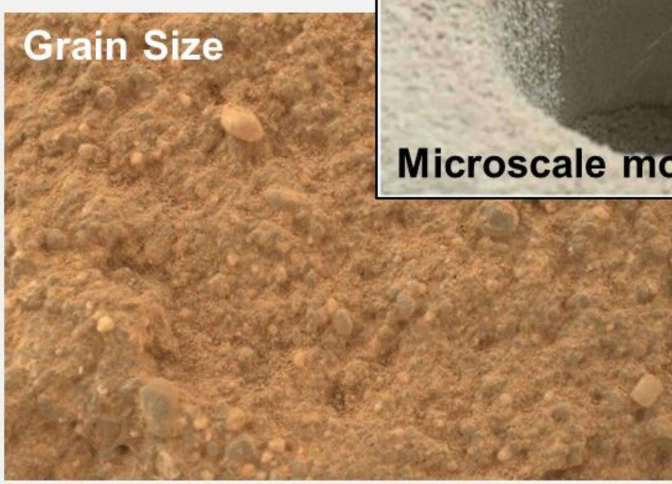
Data collected on PT1 with SHERLOC relevant parameters


13·6·11·1 Wittenoom Rd.

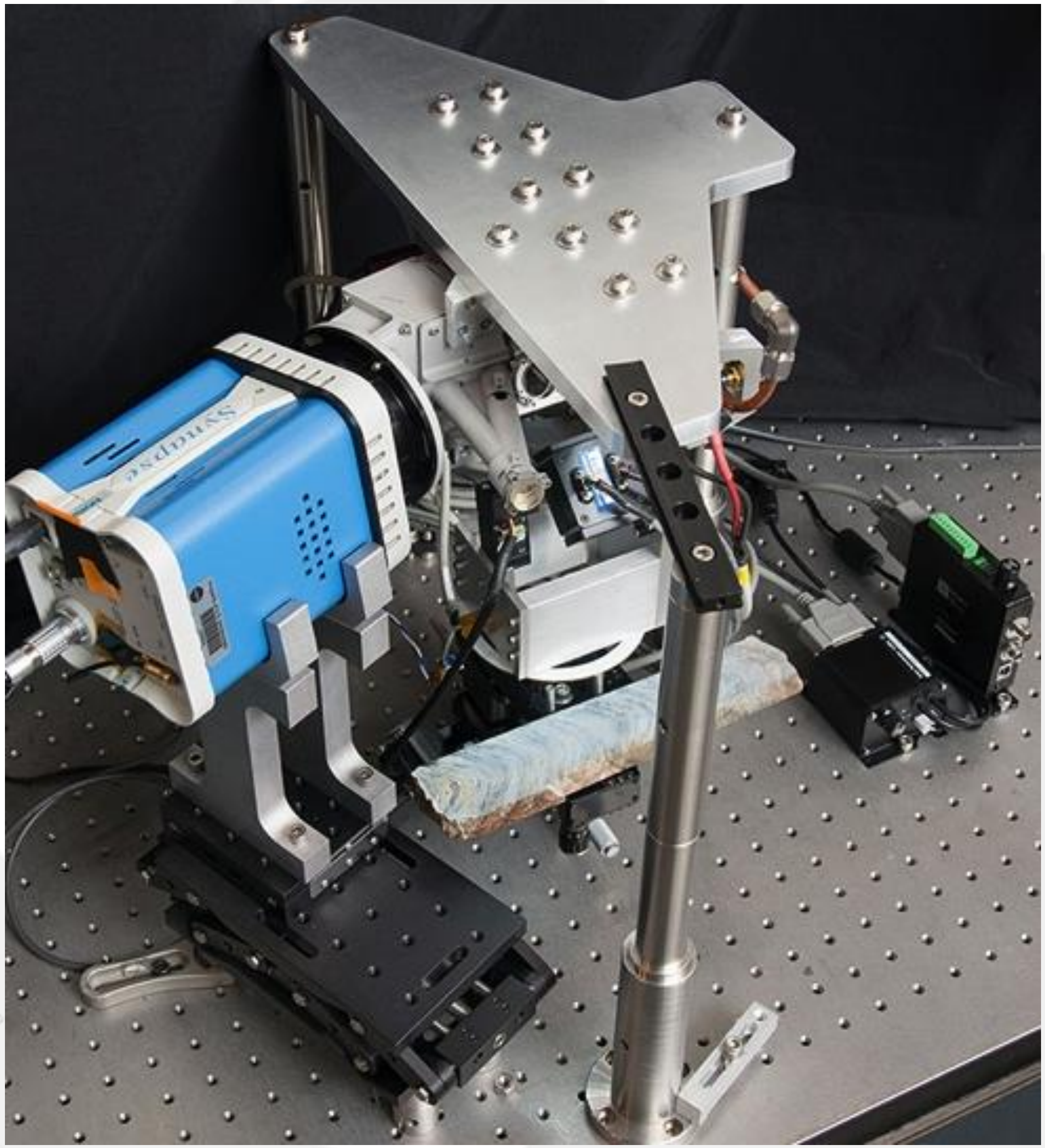
Imaging with WATSON!



Science



Laboratory Model



Planetary Protection & Contamination Control

- We clean the instrument
- Then we clean the room that holds the instrument
- Then we clean the instrument
- Then we clean the rover
- Then we clean the instrument
- Then we clean the rover
- Then we clean the instrument
- Then we clean the instrument
- Then we make sure the instrument is clean until we launch!

Preparing for future Humans: Space Suite material!

- HEOMD EVA Suit Targets
  - Orthofabric (outer layer of EVA suit outergarment)
  - 3oz. Teflon fabric (outer layer of glove, back of hand, gauntlet)
  - Polycarbonate (helmet visor)
  - RTV silicone (glove palm)
  - Vectran (glove palm)
  - Spectra (EVA suit structural element)
  - 6oz polyester (EVA suit restraints)

NOW TIME FOR QUESTIONS!

4 years and 10 months to we land on February 18th 2021

See you at the 2021 celebration with the first results!